

DWR OROVILLE FACILITIES RELICENSING PROJECT (FERC Project No. 2100)

STUDY #4: MEASURES TO IMPROVE FLOOD PROTECTION PROVIDED BY OROVILLE FACILITIES.

November 15, 2001

1.0 INTRODUCTION/BACKGROUND

Flood protection is one benefit that was delivered by Oroville dam even before it was complete. While the dam was under construction, it prevented millions of dollars of property damage and saved lives by impounding the floodwaters in 1964. Today, flood protection remains one of the major benefits of this dam.

Flood protection is essential for the health, safety and economy of the area exposed to such hazards. Even after the construction of Oroville facilities, areas along Yuba River, and Feather River (downstream of Oroville dam) have experienced disastrous floods several times such as in 1986 and in 1997. Finding ways to improve the flood protection provided by the Oroville facilities remains a significant issue.

Since the construction of Oroville Facilities in 1967, significant changes have taken place as discussed below:

- Natural growth over time has increased both the extent and the intensity of development in the Feather River and Yuba River flood plains. Both of these factors contribute to increased impact of floods.
- Significant advances have been made in:
 1. The collection/application of real-time data for forecasting reservoir inflow.
 2. The science of hydrology, topographic, and geographic mapping.
 3. Computer software used in hydrologic, and flood routing studies.
 4. The engineering of flood control structures.
- Additional water storage facilities have been constructed or planned in the Sacramento and San Joaquin River basins. Operations of these facilities affect flood conditions in the region. Floods are basin-wide and regional problems and require regional, coordinated solutions.

This study would identify and evaluate ways to improve flood protection downstream of Oroville Dam. It would also identify flood control studies by various agencies, recently completed or currently in progress, evaluate their adequacy for addressing this issue directly or with some updating.

The study would also address specific issue(s) identified in the scoping process.

2.0 STUDY GOAL(S) AND OBJECTIVE(S)

The objective of this study is to evaluate potential flood protection improvements provided by different methods. These methods would include:

- Construction of new or alteration of existing flood control structures.
- Alteration in the operations of Oroville facilities.
- Flood analysis studies that use current information and technology.
- Coordinated operations among water agencies.

3.0 RELATIONSHIP OF THE STUDY PLAN TO RELICENSING PROJECT PROCESS/PURPOSE AND NEED FOR THE STUDY

Relationship of the Study Plan to Relicensing Project Process

A comprehensive plan for developing the waterway for the beneficial public use including flood control is required by FERC. Federal Power Act states that flood control benefits of a project and the recommendations of Federal and State agencies exercising administration over flood control would be considered by FERC:

“All licenses issued under this subchapter shall be on the following conditions:

1. Modification of plans; factors considered to secure adaptability of project; recommendations for proposed terms and conditions

(1) That the project adopted, including the maps, plans, and specifications, shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, including irrigation, flood control, water supply, and recreational and other purposes referred to in section 797(e) of this title (FOOTNOTE 1) if necessary in order to secure such plan the Commission shall have authority to require the modification of any project and of the plans and specifications of the project works before approval.

(2) In order to ensure that the project adopted will be best adapted to the comprehensive plan described in paragraph (1), the Commission shall consider each of the following:

(A)

(B) The recommendations of Federal and State agencies exercising administration over flood control, navigation, irrigation, recreation, cultural and other relevant resources of the State in which the project is located, and the

recommendations (including fish and wildlife recommendations) of Indian tribes affected by the project.”

(TITLE 16-CONSERVATION, CHAPTER 12-FEDERAL REGULATION AND DEVELOPMENT OF POWER, SUBCHAPTER I-REGULATION OF THE DEVELOPMENT OF WATER POWER AND RESOURCES, Sec. 803 -Conditions of license generally)

This study aims to provide information on the improving the flood control benefits of Oroville Project, in support of the relicensing process. It addresses the following specific issues identified in the scoping process:

Issue Statement No. E5: Impact of flood releases on Lake Oroville dam (including need for access to north side of dam) and downstream facilities including downstream levee stability and potential for ameliorating downstream flooding through coordinated releases with other water storage facilities. Consider past floods, improvements in channel carrying capacities, need for more storage (e.g., installing Obermeyer gates on the emergency spillway ogee), operational changes, early warning system for downstream releases, and updating of flood operation manual.

Purpose and Need for the Study

This study is required to address the issues using the current information,. There is a lot of existing information that needs to be compiled, evaluated and possibly updated and refined. In particular, the study would consider:

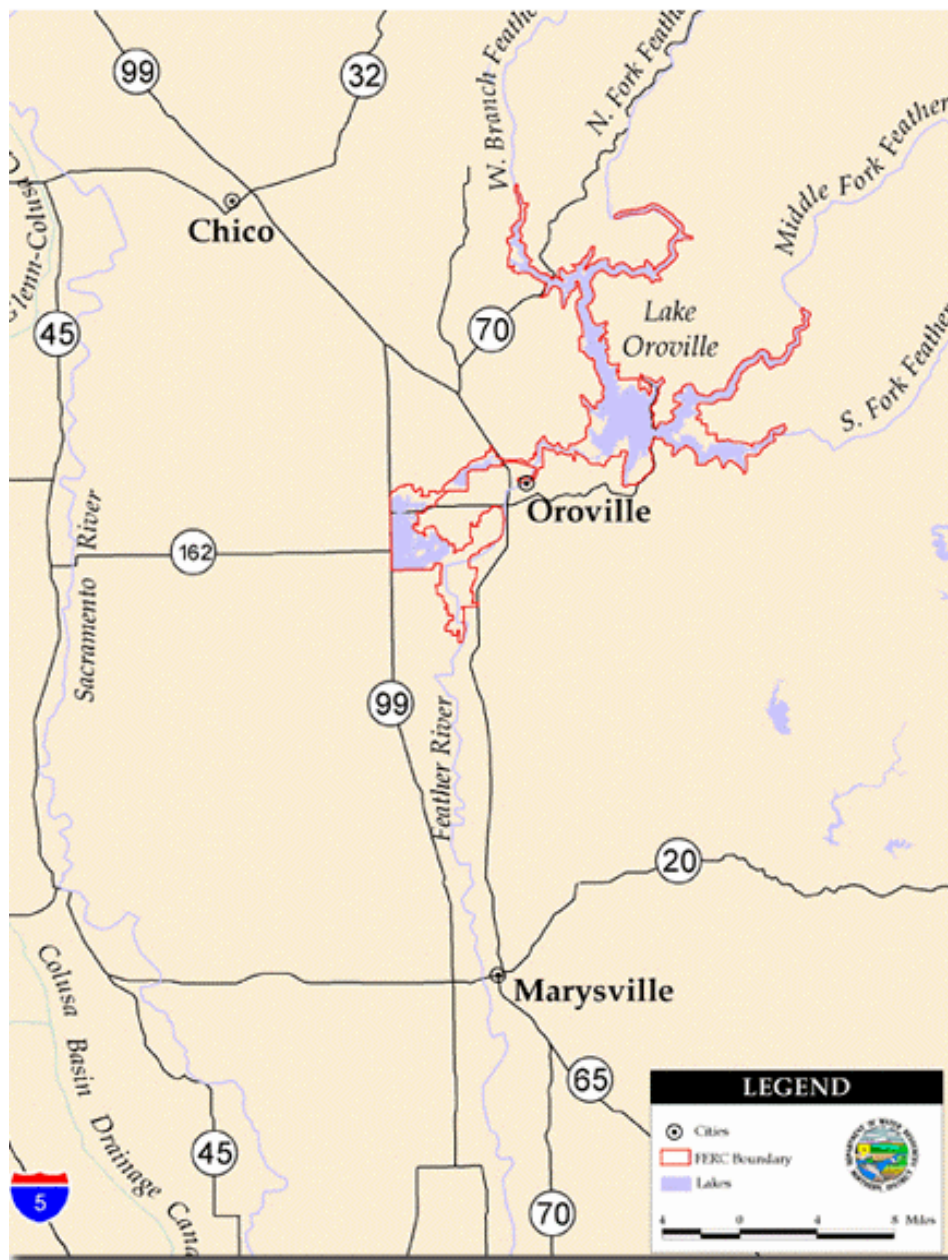
- Detailed information for soil characteristics of the Feather River Basin.
- Detailed topographic maps and advanced software allowing more accurate estimate of water surface profiles during floods.
- Proposals for changes in operation of Oroville dam during floods.
- Construction of new and/or alteration of existing facilities for flood control.

Issues Addressed

- EE11. Coordinate releases with other water storage facilities for flood release
- EE17. Update flood operation manual
- EE19. Early warning system for downstream releases
- EE21. Outflow impacts to downstream flood risk (levee stability) COE?
- EE22. Stability of Oroville levee system through low flow section and effects of high flow
- EE23. Evaluate channel capacities and potential need for more storage / flood protection engineering and operations deflection into levees by gravel bars
- EE47. In the FERC Part 12 guidelines, the Probable Maximum Flood (PMF) is to be examined after each major flood event. The Feather River has had two major flood events since 1971; once in February 1986 and again in January 1997. The FERC Part 12 regulation guidelines also state that when new Hydro-meteorological Reports (HMR's) are issued, the PMF is to be re-examined. New HMR's (HMR 58 & 59) were issued in 1999, thus precipitating the Oroville 2100 project to be re-examined in light of the new data. I think that this has been done for the 2100 project in the last Part 12 inspection and the Work Group should be given the correct data. If not done, the question is why not?
- EE51. Provide the Work Group with the study data done on installing Obermeyer Gates on the emergency spillway ogee to raise the reservoir elevation in a major flood runoff event? What is the probability of this installation?
- EE52. Provide the workgroup with the latest PMF, HMR, and PMP (probable maximum precipitation) data?
- EE53. When was the last "Inflow Design Flood" (IDF) study done and was it done on current data?
- EE56. Prepare flood inundation maps for a 1997(?) worse case with 300,000 cfs coming out of the dam's normal and emergency spillways. In 1997, it is believed that Oroville storage was almost to a point where the 300,000-cfs of inflow was going to pass through the reservoir. DWR was making plans to evacuate the power plant. The 300,000 would have topped the levees and put 10 feet of water into the town of Oroville.

4.0 Scope – Study Area

FERC Project 2100 Boundary and the Feather River upstream of the Oroville dam that forms Oroville Reservoir Watershed, and downstream to confluence with the Yuba River.



Map of Study Area (Placeholder for more accurate Map)

5.0 GENERAL APPROACH

The Issue Statement No. 5 refers to “downstream levee stability”. Project Levees on Feather River are under the jurisdiction of the US Army Corps of Engineers. They would take the lead in any Project Levee improvement program.

The general approach of the study would be to:

- Evaluate and, if necessary, update existing studies to reflect current conditions, technology and information, including:
 1. Estimating the storm precipitation
 2. Estimating run off and flood routing, and
 3. Inundation studies.
- Evaluate new concepts for their effectiveness in flood protection. This would include:
 1. Measures for advance information for inflow into Oroville reservoir,
 2. Structural modifications in the project facilities,
 3. Improvements in the river channel and
 4. Changes in the operations of dam.
- Coordinate with and incorporate the results of relevant studies being done by other agencies.

This study would avoid duplication of the work being done on any of the above items studied by other agency. Rather, it would cooperate with those efforts and use their results.

Detailed Methodology and Analysis Procedures

Task 1 – REVIEW EXISTING OR IN-PROGRESS LITERATURE ON FEATHER RIVER FLOODS.

In this task, the following existing reports would be reviewed:

1. Oroville Dam-PMF (Probable Maximum Flood) Analysis 2001:

DWR is in the final stages of completing an updated PMF analysis of Oroville Dam. The report would be issues by the end of 2001.

This update is being done in pursuit of 1999 Director's Safety Review Board Recommendations No. 1. The PMF would be developed using HMR-58. It would be routed through the Oroville Lake and Flood Control Outlets, assuming a number of scenarios:

- Full operation of all spillway gates
- No-operation of one and two spillway gates
- Minimum residual freeboard on Oroville dam, Bidwell and Lime saddle dams.

The elevation of Oroville Reservoir at the start of event is 848 feet. The analysis would consider the criteria set forth by the Report on Reservoir Regulation for Flood Control in 1970. "Releases from Oroville Dam are not to be increased more than 10,000 cfs nor decreased 5,000 cfs in any 2-hour period". This criteria is expected to have significant effect on reservoir water surface elevation.

2. Inundation Studies:

A. Flood Inundation Study of the Feather River by DWR- 1998

B. Oroville Dam Inundation Maps by the US Army Corps of Engineers-2000

C. Feather River Backwater Analysis by Corps of Engineers 2001

A. Flood Inundation Study of the Feather River by DWR- 1998

DWR completed the 1998 study to assess the affect of flood releases from Oroville Dam. Inundation maps showing the extent of flooding were prepared. The maps delineated the boundaries of flood flows of 150,000 cfs (Standard Project Flood Release) and 400,000 cfs.

As a check of computations, the surveyed high water elevations during the flood of January 1997 were compared with the computed profile of the same discharge.

Major features and assumptions of the study were:

- Only two cross sections, below Oro Dam Blvd. were actually surveyed. Other flood plain geometry and cross sections were determined from USGS Quadrangle maps, previous USGS studies, and photogrammetric surveys. Channel depth was determined from field inspection and from a 1994 fish habitat study performed by DWR.
- Flow was assumed steady between cross sections, gradually varied, and one-dimensional.
- Levees: All existing levees are intact for flows up to 150,000 cfs.

The study found that flows greater than 150,000 cfs encroach the west levee free board just downstream of East Gridley Road at less than 3-feet from the top of the levee. The capacity of the west levee near the town of Gridley is approximately 270,000 cfs.

B. Oroville Dam Inundation Maps by the US Army Corps of Engineers-2000

The Corps of Engineers prepared the Inundation Map in October 2000 at the request of DWR. This latest map is a part of the Emergency Action Plan for Oroville facilities.

C. Feather River Backwater Analysis by Corps of Engineers 2001

US Army Corps of Engineers is doing a study of the water surface profiles in the Feather River (from Oroville Dam to the Confluence of Feather River with the Sacramento River) during a 10, 50, 100 and 500 year flood. It also includes a Floodway Analysis of the 100-year flood. It is not an inundation study for Dam Break flood, but a statistical flood analysis study.

The study is expected to be complete shortly, although firm schedule is not available.

3. Forecast Based Operation (Advance Release) of Oroville Dam.

US Army Corps of Engineers and the US Bureau of Reclamation are in the process of developing a Flood Management Plan for American River using this concept. The Water Resources Development Act of 1999 directed the Corps and the Bureau to update the Flood Management Plan to reflect the improved weather forecasts based on the Advanced Hydrologic Prediction System of the National Weather Service. Corps is leading a multi agency team working on this plan.

The Comprehensive Study, lead by US Army Corps of Engineers, and the Reclamation Board of the State of California as well as the Yuba-Feather Flood Protection Program lead by Yuba County Water Agency would evaluate the use of this concept for Oroville Dam operations to improve flood protection. The Comprehensive Study is scheduled for completion in early 2002, however the completion of Yuba-Feather Flood Protection Program is not firm.

The innovative program relies upon more on the best available data and less on rule curve. The methodology allows advance releases based on:

- Inflow forecast by measuring precipitation in the watershed.
- Using uncertainty estimates along with best estimates of forecast hydrograph.

Inflow forecasts by measuring the precipitation in the watershed may advance releases by several hours. Releases may also be based on precipitation forecasts by observing incoming storms, which could allow for releases several days in advance. Reservoir elevation, inflow and outflow conditions preceding a major storm are major factor in determining the size of advance release.

The effect of advance releases is to create additional flood space in the reservoir and are to be used for rare storms. The size of advance release would have economic effects, therefore a range of advance release sizes would be studied.

Task 2 – UPDATE STUDIES

This task would be carried out if the review of the above (existing and in-progress) studies shows that current information would significantly change the conclusions of these studies.

1. Oroville Dam PMF Analysis Study

The type of soil cover in a watershed basin directly affects the run off its characteristics. This information was previously determined in an approximate manner. However, as a part of relicensing, DWR has GIS database that includes more detailed information on soil cover. The impact of this information on the storm run off would be evaluated. If this is found significant, the study would be updated.

2. Flood Inundation Maps of the Feather River

Water surface computation software used in these studies assumed steady flow in the river. The impact of using modern flood routing software that allows non-steady flow would be evaluated. If this is found significant, the study would be updated.

3. Forecast Based Operation of Oroville Dam.

If the review of Flood Management Plan for American River, and Sacramento and San Joaquin River Basins, The Comprehensive Study, and the Yuba-Feather Flood Protection Program shows that additional local or site specific factors would not have significant impact on the conclusions, no update would be necessary. The results would be directly incorporated into the report. Otherwise, Forecast Based Operation of the Oroville Reservoir would be revisited.

Task 3 – CONDUCT STUDIES

1. Evaluation of Effect of Changes in Channel Geometry on the flow capacity downstream of Oroville Dam.

As a part of relicensing, the Environmental Resources Work Group would be studying changes in channel geometry. These changes would affect the channel flow capacity. DWR is responsible to maintain the project flow capacity of the channel. This study would evaluate the effect of changes in channel geometry, including removal of islands in the channel, on the flow capacity.

2. Update Flood Operations Manual by USACE.

Flood Operations Manual is in the jurisdiction of USACE. It is possible that in the light of various flood control studies about Oroville Dam, and Folsom Dam, the Corps would make changes in the Flood Operations Manual. It is not a study that DWR would undertake. It is listed here simply as a possible that might impact the flood protection provided by Oroville Dam.

Task 4 –COORDINATE AND COOPERATE WITH ONGING STUDIES BY OTHER AGENCIES.

There are two studies currently underway which would affect Oroville Facilities Flood Control Operations as discussed below:

1. Yuba-Feather Flood Protection Program (Y-FFPP)

After the 1997 floods, Yuba County Water Agency initiated a seven-phase program (Yuba River Supplemental Flood Control Program) to provide flood control on Yuba River. However the passage of Water Act of 2000 has authorized immediate funds for flood control on Yuba and Feather rivers. Thus the Yuba County Water Agency has begun implementation of Yuba-Feather Flood Protection Program. The schedule of the Y-FFPP is “as soon as possible”.

The purpose of Y-FFPP is “to define and implement, as soon as possible, a cost effective, practicable program within the budget of the Water Act of 2000 to provide the greatest possible increment of protection against flooding from Yuba and Feather Rivers.” This program has three potential elements that involve Oroville Facilities:

- **Lake Oroville Enlargement.** Modifications to the emergency spillway to temporarily raise flood levels by 10 to 15 ft. Modifications include inflatable gates, fuse gates, or an inflatable dam on top of the emergency spillway.
- **Thermalito Afterbay Emergency Re-Operation:** Operational storage would be incorporated into flood operations by evacuating in advance of a forecast major storm event. Structural changes would not be needed.
- **Forecast Based Operation of Oroville Dam:** Utilizing National Weather Service Forecasts up to 3 days in advance of actual flows, the reservoir would be drawn down to create additional flood space.

The results of these three program elements would directly affect this study and the information developed regarding these elements would be considered in this study.

2. Sacramento and San Joaquin River Basins, Comprehensive Study

The Comprehensive Study will identify problems and opportunities, set planning objectives and priorities, and develop potential measures to address flood damage reduction and ecosystem restoration. The study will examine a full range of structural and nonstructural measures and strategies to ultimately lead to a new master plan for flood management for the Sacramento and San Joaquin River systems.

The study is lead by US Army Corps of Engineers, and the Reclamation Board of the State of California. The four-year Comprehensive Study has been divided into two phases. Phase I was 18 months long and concluded with preparation of an Interim Report in April 1999. Phase II, now underway, includes evaluation of alternatives and preparation of master plans and associated Programmatic EIS/EIR documentation.

The study will conclude in 2002.

Task 5: REPORT

A report will be prepared summarizing the work completed in each task.

6.0 RESULTS AND PRODUCTS/DELIVERABLES

Results

The results of the study would consist of:

1. Maps showing areas inundated by floods of various flows under present conditions.
2. Identification of various measures and changes (structural and non structural) on the flood protection provided by Oroville facilities.
3. Quantitative and qualitative effects of the flood protection measures in the following areas:
 - Engineering
 - Economics
 - Environmental Impacts
 - Recreation
 - Regulatory Environment
 - Water Supply

Products/Deliverables

The product of this study will be a comprehensive report on the evaluation of various flood protection measures and Inundation Maps.

7.0 STUDY PLAN COORDINATION AND IMPLEMENTATION STRATEGY

Coordination with Other Resource Areas/Studies

This study does not depend upon the input from any other work group. However, it would consider the impacts of various flood control measures on other resources. Therefore, it would have consultation-level linkage with the following work groups:

- Cultural Resources Work Group.
- Recreation and Socioeconomic Work Group.
- Land Use, Land Management and Aesthetics Work Group.
- Environmental Work Group.

Organizations within DWR involved in the study:

- DWR-Division of Engineering
- DWR-Division of Operations and Maintenance
- DWR-Division of Flood Management

Agencies with related activities:

- US Army, Corps of Engineers
- US Bureau of Reclamation
- Yuba County Water Agency
- Butte County
- City of Oroville
- City of Yuba City
- Sutter County

Study Plan Tracking/Regulatory Compliance Requirements

The relicensing process requires that issues identified in the scoping process must be addressed. This study complies with the relicensing process by addressing Issue Statement No. E5: "Impact of flood releases on Lake Oroville dam (including need for access to north side of dam) and downstream facilities including downstream levee stability and potential for ameliorating downstream flooding through coordinated releases with other water storage facilities. Consider past floods, improvements in channel carrying capacities, need for more storage (e.g., installing Obermeyer gates on the emergency spillway ogee), operational changes, early warning system for downstream releases, and updating of flood operation manual."

8.0 REFERENCES

Provide a complete list of references with full citations of literature cited or used in completion of the study.

ATTACHMENTS (EXAMPLES)

A- RELEVANT STAKEHOLDER/WORK GROUP ISSUE SHEET(S)

B- ORIGINAL COMMENTS PROVIDED BY STAKEHOLDERS ADDRESSED BY THE STUDY PLAN

C - DATA COLLECTION/FIELD SURVEY DATA SHEETS

D - DATABASE TEMPLATES

E - SUMMARY REPORT - ANNOTATED OUTLINE

DWR OROVILLE FACILITIES RELICENSING PROJECT (FERC Project No. 2100)

STUDY PLAN IMPLEMENTATION ISSUES DWR FILE/TEAR SHEET TEMPLATE

October 1, 2001

Study Plan Resources

Identify agency personnel, equipment, and other resources needed to successfully implement all phases of the study plan. State anticipated need for resource specialists or technical consultants in the completion of the study plan. Present as hours by task by staff/expert.

Study Plan Implementation Schedule

To be determined.

Identify the anticipated schedule for completion of study plan tasks, draft and final product(s). Provide timeline indicating inter-relationship of study plan tasks with key milestones for individual tasks.

Study Plan Implementation Costs

Determine and present start-up and on-going costs associated with all phases of study plan implementation. Identify anticipated funding sources and mechanisms.